APPENDIX L

PLAN FORMULATION

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APPENDICES

1.0 INTRODUCTION

The purpose of this appendix is to present the detailed, reference, and background information that was not included in the DPR. Specifically, the purpose of the appendix is not to duplicate the material included in the DPR, but instead provide information that was not presented in the main report for those readers that are interested in this detailed and background information.

2.0 PRELIMINARY PROBLEMS, OPPORTUNITIES, CONSTRAINTS, CONSIDERATIONS

On July 9, 2003, the Corps' PDT met to brainstorm Problems, Opportunities, Objectives and Constraints associated with the project. Table 1 is a summary from this meeting.

Table 1. July 2003. Brainstormed UYC Problems, Opportunities, Constraints, Considerations.

Problems (15)	Opportunities (17)	Constraints (4)	Consideration (7)
Aesthetics	Create dam removal team and/or template for future similar projects	Dam is an historical landmark	Regulatory agencies (consensus, etc)
Low flow channel	Create jobs	Access to the area is difficult (construction and recreation issue)	Safety (during construction)
No fish passage	Demonstration projects for bank stabilization (test new techniques)	Project location might create issues with construction mobilization/demobilization areas	Safety (for tourists, cyclists)
Non-native species	Good PR for Corps	Habitat for Special status species (Redwood trees, fish, birds, frogs, oak trees)	Mitigation
Radical grade drop of stream channel might create problems for fish passage	Improve safety around project area		Lack of info on downstream conditions, channel features, etc. Induced flooding?
Riparian zone needs improvement	Improve watershed		City needs a construction easement for the project site
Road needs stabilization	Improve water quality		No records from city
Soil contamination	Increase level of flood protection		
Banks Erosion	Increase tourism revenue		
There are bridges, utilities, obstructions, etc downstream of the dam that might be affected by scour	Increase/improve access to site		
Sedimentation and future disposal	Prevent further erosion to project site		

There is seismic activity in the project area	Recreation opportunities		
Upstream conditions: erosion and bank stabilization	Remove contaminated soil/material		
Vegetation is overgrown	Remove non-native species		
Water quality	Restore more natural channel alignment		
	Restore riparian zone/habitat in Upper York Creek		
	No bike lanes, trails, etc. for recreation		

3.0 PRELIMINARY OBJECTIVES

In addition to developing the Problems and Opportunities, the PDT also developed the initial iteration of Objectives and Opportunities at the July 9, 2003 meeting. Table 2 is a summary of these Objectives and Opportunities.

Table 2. July 2003. Brainstormed UYC Objectives and Opportunities.

Objectives	
Improve Fish Passage	This objective has been retained in final array of objectives.
Sediment removal	This initial objective has been revised to show its connection to federal objectives. The current objectives that are related to sediment removal are (1) Reduce future downstream habitat degradation and fish kills; and (2) Habitat Restoration. Sediment removal is now a measure that is necessary to meet the above objectives.
Erosion Control	Erosion control is not considered a priority federal mission but is necessary to reduce future downstream and onsite project impacts. Erosion control measures have been included as part of the Revegetation Plan
Habitat Improvement	This objective has been retained in the final array of objectives as “Habitat Restoration.”
Opportunities	
Create a natural hydraulic flow through the project site	This Opportunity has been retained as an “objective” in the final array of objectives as “Connectivity.”
Flood Control	Flood Control is not included as a final objective or opportunity as the dam does not currently provide flood control. Increased downstream sediment deposition, due to dam removal or modification could increase flooding potentials in the downstream areas of York Creek. This potential will be further studied and will be mitigated for prior to construction in the

	Design and Implementation Phase.
Natural Channel Alignment	This Opportunity has been retained as an "objective" in the final array of objectives as "Connectivity."
Recreation/Safety	This Opportunity has not been retained in the final array. The project site does not currently allow for recreation and public safety is incorporated into construction methodology and post construction safety is the responsibility of the sponsor.

4.0 PRELIMINARY MEASURES AND ALTERNATIVES

On November 20, 2003 the Corps' PDT held its first Preliminary Alternatives meeting where measures were brainstormed to address the Problems and Opportunities developed at the July 9, 2003 meeting. Table 3 is a summary of the initial brainstorm of measures. Table 3 helps illustrate that the primary difference in the initial array of alternatives are the measures to address the fish passage objective. This was done as this specific objective demanded the most intensive engineering and design effort for this restoration project. This objective also most directly affects the outcome of all project objectives.

Table 3. Brainstormed Upper York Creek Planning Measures. November 2003.

Measure #	Measure	Retained	Dropped	Constraint	Notes
Objective: Erosion Control (22)					
78	Leave large trees to reduce erosive effects of rainfall	x			
76	Bioengineering techniques	x			
80	Boulders	x			
70	Buy out vineyards and revegetate	x			
63	Do nothing/Mother Nature	x			
72	Glue or other additives for soil cohesion	x			
82	Grade control	x			
66	J-hook weirs	x			
73	Meanders	x			
75	Mulch	x			
77	Plant aquatic vegetation	x			
65	Plant deep-rooted vegetation	x			
68	Redirect water away from problem areas	x			Design feature
71	Regrade and stabilize stream banks	x			Design feature
81	Restrict public access	x			
74	Rip rap	x			Design feature
79	Sedimentation study	x			
69	Silt curtains	x			
67	Concrete trapezoidal channel		x		

64	Plant upstream		x		
83	Restrict animal access		x		
84	Sand bags		x		
Objective: Fish Passage (22)					
37	Add more water/increase flow	x			
31	Build fish hatchery	x			
20	Dam Removal	x			
29	Dam Removal and regrade	x			
25	Fish bypass	x			
30	Fish escalator	x			
35	Fish lift	x			
19	Fish Tube	x			
32	Landscape improvement	x			
26	Modify spillway structure	x			
36	Notch or lower dam	x			
34	Remove downstream diversion structure	x			
24	Remove excess sediment	x			
27	Replace fish ladder	x			
38	Reroute creek around dam	x			
28	Trap and truck fish around dam	x			
40	Weirs	x			
33	Burn and Pave		x		
21	Fish Boats		x	channel size	
39	Kill fish		x		
23	Make fish healthier		x	impossible	
22	Outlaw fishing		x		
Objective: Habitat Improvement (22)					
54	Buffer zone	x			
51	Chemically enrich water	x			
47	Control sedimentation	x			
41	Do nothing/Mother Nature	x			
60	Excavate fines	x			
43	Excavate sediment	x			
42	Landscape improvement	x			
50	Large woody debris	x			
53	Limit public access	x			non structural
58	Management Plan	x			non structural
56	Meanders	x			
49	Modify in flow	x			
62	Plant native species	x			
44	Plant stuff fish like	x			
48	Plant vegetation to create shaded aquatic habitat	x			
46	Regulate upstream land use	x			non

					structural
61	Remove exotic/invasive plants	x			
57	Terrace banks	x			
55	Weirs	x			
52	Import endangered species		x		
59	Music		x		
45	Road removal		x		
Objective: Sediment Removal and Erosion Control (18)					
6	Build toe/stabilize slope	x			
2	Clean Up, Enrich it, and leave in place	x			
1	Excavate sediment	x			
9	Excavate, parse, and sell	x			
7	Leave it/do nothing	x			
8	Leave it/manage for fish passage	x			
3	Move it somewhere allowable	x			
5	Reuse at project site	x			
17	Sedimentation study	x			
18	Convert to some other material		x	not possible	
16	Donate/give away		x	HTRW - asbestos	
4	Incrementally flush downstream		x	Water quality	
11	Sell as souvenirs		x	HTRW - asbestos	
13	Sell for landscaping		x	HTRW - asbestos	
14	Sell for sandbags		x	HTRW - asbestos	
12	Sell to plant nurseries		x	HTRW - asbestos	
15	Sell to vineyards for use		x	HTRW - asbestos	
10	Use for making playground sandboxes		x	HTRW - asbestos	
Opportunity: Channel Flow (12)					
164	Dam removal	x			
166	Divert agricultural runoff	x			
159	Eliminate in-stream diversions	x			
157	Low-flow channel	x			
162	Monitor temperature, flow rate	x			
160	Offstream storage and distribution	x			
167	Plant vegetation	x			
158	Recharge aquifer/groundwater	x			
165	Re-operate dam	x			
163	Tributaries	x			
156	Water pipeline/import water	x			
161	Reduce friction - concrete		x		
Opportunity: Flood Control (27(					
91	Build new dam/ regulate water release	x			
104	Bypass channel	x			
95	Clean out sediment	x			
89	Control erosion	x			
109	Do nothing/Mother Nature	x			

105	Elevate road	x			
103	Elevate Structures	x			
108	Heighten levees	x			
96	Improve drainage system	x			
88	Increase dam height	x			
102	Meanders	x			
106	Offstream flood storage	x			
87	Plant trees	x			
90	Plant vegetation	x			
92	Remove structures from flood plain	x			
107	Reroute creek from dangerous areas	x			
97	Rezone and evacuate	x			
101	Set back levees/wetland restoration in lower reaches	x			
94	Wetlands/detention basin behind dam	x			
110	60-inch French Drain in Project Area		x		
85	Concrete trapezoidal channel		x		
86	Earthen trapezoidal channel		x		
98	Excavate deeper channel in AE and Residential Areas		x		
93	Move road		x		
100	Reduce/eliminate water flow		x		
111	Sewers		x		
99	Widen channel in AE and Residential Areas		x		
Opportunity: Restore Natural Channel Alignment (22)					
149	Bioengineering techniques	x			
153	Cut a "natural" channel through city	x			
137	Dam Removal	x			
135	Do nothing/Mother Nature	x			
140	J-hook weirs	x			
139	Large woody debris	x			
136	Meanders	x			
145	Plant vegetation	x			
141	Purchase adjacent property	x			
142	Regrade and stabilize stream banks	x			
150	Remove bridges over creek	x			
147	Remove downstream diversion structure	x			
151	Remove downstream levees	x			
152	Remove invasive species and non-natives	x			
134	Remove Sediment	x			
148	Remove/relocate utilities near stream/road	x			
143	Road removal	x			
138	Weirs	x			
154	Eliminate public access		x		

146	Mattresses, furniture		x		
155	Reduce agricultural activity in upper watershed		x		
144	OOPS		x		
Opportunity: Recreation and Safety (22)					
114	Bike lanes	x			
119	Education stations	x			
117	Fish and wildlife viewing platform	x			
128	Fences to trap landslides	x			
124	Guard rails	x			
133	Hiking trails	x			
127	Law enforcement	x			non structural
126	Outreach program	x			non structural
131	Parking spaces	x			
116	Purchase adjacent property	x			non structural
122	Restrict public access	x			
113	Road amelioration	x			
121	Signage-- interpretive and warning	x			Should be bilingual
132	Stabilize banks	x			
129	Stairs to water	x			
115	fast food restaurants		x		
120	Bait & tackle stand		x		
112	Close road		x		
125	Remove poison oak		x		
123	Road/area lights		x		
118	Slow food/wine tasting		x		
130	Vending machines		x		

Below, table 4 is a “Preliminary Alternative Chart” that allowed the team to see how the preliminary measures addressed the preliminary objectives and how they would be sorted into alternatives.

Table 4: Preliminary Alternative Chart

	INITIAL OBJECTIVES					INITIAL OPPORTUNITIES			
Alternative Name	Fish Passage	Sediment		Erosion control	Habitat improvement (measures not already included)	Channel flow (measures not already included)	Flood control (measures not already included)	Natural Channel Alignment (measures not already included)	Recreation/Safety (measures not already included)
No Action	N/A								
1	Remove Dam; build support structure for road (pilings, elevated roadway, etc)	Excavate	Dispose	J-hook weirs, Bioengineering techniques, Boulders, Vegetation (Trees, deep-rooted veg, aquatic veg), Meanders/direct flow away from problem areas, Regrade and stabilize stream banks, Riprap (only where necessary), Sedimentation Study	Large woody debris, Remove exotic species, Management plan, Buffer zone	Divert agricultural runoff, Eliminate in-stream diversions, low-flow channel, offstream storage and distribution, Recharge aquifer/groundwater, Tributaries, Water pipeline/import water	Elevate road, *Heighten levees*, Improve drainage system, *increase dam height*, Remove structures from flood plain, Rezone and evacuate, Setback levees/wetland restoration in lower reaches, Wetlands/detention basin behind dam	Cut a "natural channel through city, Purchase adjacent property, *Remove downstream levees*, remove/relocate utilities near stream/road	Bike lanes, Education stations, F&W viewing platform, Fencing to trap landslides, Guard rails, Hiking trails, Law enforcement, Outreach program, Parking spaces, Road amelioration, Signage--interpretive and warning, Stairs to water
2			Parse, sell						
3			Reuse/redistribute at site						
4	Modify Dam (notch/lower/leave half of dam)	Excavate	Dispose						
5			Parse, sell						
6			Reuse at site						
7		Leave in place	Clean up and enrich						
8	Fish Passage structure assoc w/dam (escalator, ladder, lift, or tube); Leave/raise Dam	Excavate	Dispose						
9			Parse, sell						
10			Reuse/redistribute at site						
11		Leave in place; stabilize	Do nothing						
12			Clean up and enrich						
13	Reroute Creek (by spillway?)/Bypass channel; modify Dam	Excavate	Dispose						
14			Parse, sell						
15			Reuse/redistribute at site						
16		Leave in place; stabilize	Do nothing						
17			Clean up and enrich						

5.0 DEVELOPMENT OF ALTERNATIVE BENEFITS

For the purposes of this project, NCRCD assisted the Corps by combining habitat data for York Creek with current rainbow trout density data to produce an estimated steelhead carrying capacity. This produced an estimate for the number of steelhead that York Creek could support from the base of the dam, though the project site, and to the uppermost reach of York Creek. Estimates are based on rainbow trout populations in September 2005. It would therefore be estimate that the population was 4-6 months in age.

Habitat survey data collected in 2003 by NCRCD were compiled for the reaches above the Upper York Creek Dam to the end of potential steelhead habitat at a bedrock falls (NCRCD, 2005). These data were used to calculate usable habitat estimates for juvenile steelhead rearing. For more information, please see Appendix 4 of this appendix.

Steelhead densities calculated from electrofishing efforts by Stillwater Sciences (2005) were then assigned to each habitat category to estimate potential carrying capacity. For more information, please see Appendix 3 of this appendix.

For background information on how the alternative benefit quantification was developed, please refer the following:

- Appendix 1: UYC Alternative Benefit Quantification Meeting
- Appendix 2: Summary of the Development of Benefits Quantification for UYC
- Appendix 3: York Creek Steelhead Carrying Capacity Model
- Appendix 4: Upper York Creek Habitat Quantification

6.0 UPPER YORK CREEK INCREMENTAL COST ANALYSIS

For background information on the Incremental Cost Analysis, please refer to Appendix 5: Incremental Cost Analysis. This is the summary provided by Greg Rothman, SPN Economics.

Appendix 1:

UYC Alternative Benefit Quantification Meeting Memo

UYC Alternative Benefit Quantification Meeting Memo

Thursday April 13, 2006
8:00 – 9:30am
Location: DFG Conference Room

Attendees:
Joél Benegar, SPN Planner
Peter LaCivita, SPN Fisheries Biologist
Jonathan Koehler, NCRCD
Greg Martinelli, DFG,

Meeting Purpose: To discuss a mechanism for quantifying the benefits to the steelhead population based on the current Corps' dam removal and/or modification alternatives.

Notes from Meeting:

Fish Ladder:
- Water will go subsurface in the summer months with a fish ladder in place
- Lower opportunity for fish passage b/c inadequate flows
- Unfavorable hydro conditions for downstream passage
- Would need a sort of less-permeable channel liner so that water does not go subsurface
- Generally, York creek flows later in the season than other tributaries to the Napa R.
- A perfectly designed and maintained ladder would perhaps be 90-100% effective?
- Would become completely blocked at least every year/two years/with every storm (depends)
- If maintained every week, then better
- Can it pass sediment?
- Sulpher creek fish ladder is blocked with every storm event
- Maintenance:
    - Would require equipment
    - Necessary weekly and with every storm from December-April
    - At least one person needed
    - Pick, shovel, chainsaw, dump truck, backhoe
    - Could have 1000lbs rocks/boulders stuck in ladder
    - One large clearing prior to every storm season
    - Normal sediment would drop out in ladder

Passage Effectiveness / Efficiency:
- Consider flow, duration of flow, duration of migration, juvenile/adult/smolt
- Adult: Migration (Dec-April)
    - Would expect blockage/not ideal conditions for upwards migration
    - Would need a foot of water in each ladder-step pool for success

  - Could we quantify the above to come up with a %effectiveness based on the hydraulics in the creek? For example, when (due to the ladder) will there not be enough water for migration? We could use this loss of migration days to develop percentage effectiveness.
  - Could we simply use professional judgment and agree and a broad range for % effectiveness?
  - Peter LaCivita is uncomfortable with the above and favors a method that is based on some sort of data—hydraulics, flows, # storm events per year.
- Smolt out migration: (Jan-May)
  - Ride out on tail of hydrograph
  - Expect 80-90% effectiveness
- Juvenile Dispersal: (year round)
  - June –Oct would have 0% effectiveness
  - 5/12 months would be effective

***Per Peter LaCivita: If the fish ladder lessens the ability of an endangered species to migrate, this is considered "take" per the ESA.**

<u>Summary of Meeting</u>

As the plan formulator, my intentions for this meeting was to brainstorm the pros and cons with building a fish ladder on this creek and then trying to develop a broad range for "effectiveness" that would reflect the likely success rate for steelhead migration.

At the end of the meeting, it was clear that Peter was not comfortable with assigning this sort of percentage without using some other existing data as a foundation for this sort of formulation. I am going to talk with our Corps' Geomorphologist, Bill Firth, to see if it is possible to base this effectiveness estimate on the hydraulics of the project site for Alternative 3: Fish Ladder.

Appendix 2:

Continued Development of Benefits Quantification for UYC

Summary of the Continued Development of Benefits Quantification for UYC

Project Planner: Joél Benegar
Date Summary Written: June 1, 2006

After the April 13, 2006 meeting, I worked with Bill Firth, SPN Geomorphologist, to try to determine when the fish ladder would have adequate flows for fish passage. After talking with Bill, it was clear, that it would require substantial work from the H&H section and that without a full scale geomorphic analysis and extensive sediment onsite work, that we could not develop this assessment.

As another option/compromise, I contacted Jonathan Koehler (NCRCD) to ask if there is hydrological data on York Creek that I could have access to determine how many storm events tend to occur in this watershed. My intention was to use this data to estimate how many times per year the ladder would be plugged. Based on how many storms, I could estimate how many migration days could be lost on an average year.

Jonathan Koehler put me in contact with Paul Blank, NCRCD who emailed the below to me:

From: Paul Blank [mailto:paul@naparcd.org]
Sent: Wednesday, May 17, 2006 11:29 AM
To: Benegar, Joel R SPN
Cc: Jonathan Koehler
Subject: RE: york hydrology info

Ms. Benegar:

RCD biologist Jonathan Koehler asked me the following question, and requested that I forward the answer to you: How many storms can we expect, in an average year, to produce fish-ladder-clogging debris on York Creek?

RCD operates a streamgaging station on York Creek at HWY29, for the City of St. Helena. The gage was installed in Dec 2005, and the data indicate that there were 13 "large" spikes in the stage record during the past rainy season. Unfortunately, I don't know the water level in York Creek at which significant amounts of debris are mobilized, but I doubt that the little blips in between these 13 spikes could produce a lot of debris. Therefore, during this past rainy season, some or all of these 13 streamflow events could have clogged a fish ladder. Since this was an active rain year, I would guess that a fish ladder might become clogged up to 10 times in an average year. If only the largest flows produce enough debris, then I would expect 6-7 clogs this past year, and 4-5 in an average year.

This is all guesswork, but I hope it helps.

Please let me know if I can be of further help.

Using the above estimate for number of storms per year, I estimated that of the 150 migration days for adult steelhead, the fish ladder could potential clog 4-7 times in any given year. This could result in a loss of 2-7 days with each clog event depending on how long it takes to clear the fish ladder. Using these estimates, the fish ladder could block upstream migration 8-49 days each year, or 5-33% of all migration days could be lost. Therefore, these preliminary blockage estimates indicate that a fish ladder would provide for 67-95% effectiveness when compared to notching or removing the dam.

Appendix 3

York Creek Steelhead Carrying Capacity Model

Napa County Resources Conservation District (NCRCD)

York Creek Steelhead Carrying Capacity Model - Napa County RCD (March, 2006)

Habitat survey data collected in 2003 by NCRCD were compiled for the reaches above York Creek dam to the end of anadromy at a bedrock falls. These data were used to calculate summary statistics for usable habitat area for juvenile steelhead rearing. Average widths and depths were calculated and assigned to each habitat unit for the reach to arrive at total available habitat. Steelhead densities calculated from electrofishing efforts by Stillwater Sciences (2005) were assigned to each habitat category to estimate potential carrying capacity. High and low density estimates represent the highest and lowest recorded value respectively. Moderate estimates are the average of the two.

HABITAT	Above Restored Area (sq ft)	Habitat+Restored Habitat (sq feet)	Acres
TOTAL POOL AREA (sq. ft.)	11,053	13153	0.30
TOTAL FLATWATER AREA (sq. ft.)	13,016	14297	0.33
TOTAL RIFFLE AREA (sq. ft.)	34,705	36994	0.58
	58,774	**64444**	**1.21**

FISH DENSITY (# of steelhead per square foot)			
	High	Moderate*	Low
Pool	0.053	0.0375	0.022
Flatwater	0.021	0.015	0.009
Riffle	0.022	0.0165	0.011

** Calculated values*

HABITAT	length (ft)	Habitat+Restored Habitat (feet)	Acres
TOTAL STREAM LENGTH (ft.)	8,030	8855	2

ESTIMATED CARRYING CAPACITY			
	HIGH	**MODERATE**	**LOW**
POOL	697	493	289
FLATWATER	300	214	129
RIFFLE	814	610	407
TOTAL STANDING CROP	**1,811**	**1,318**	**825**
STEELHEAD PER 100 ft.	**23**	**16**	**10**

Appendix 4

Upper York Creek Habitat Quantification

Napa County Resources Conservation District (NCRCD)

Habitat Class	Habitat Type Code	Habitat Unit Type (Count)	Fully Measured Units (Count)	Total Surveyed Length (Feet)	Habitat Unit Width (Sum of all measured units)	Average Unit Width feet	Average Unit Length (Feet)	Total Area (sq. ft.)	**Restored Total Length (feet)**	**Restored Total Area (sq. ft)**	**Total Area (Restored Area + Above Project Area) (sq. ft)**
RIFFLE	1.1	**6**	1	292	8	8.0	48.7	2336			**2,336**
	1.2	**75**	6	4607	42	7.0	61.4	32249	**327**	**2289.0**	**34,538**
	2.2	**1**	0	16			16.0	120			**120**
GLIDE / RUN	3.2	**23**	1	663	9	9.0	28.8	5967			**5,967**
	3.4	**14**	2	1007	14	7.0	71.9	7049	**183**	**1281.0**	**8,330**
MAIN CHANNEL POOL	4.2	**38**	11	753	91	8.3	19.8	6229			**6,229**
	4.4	**6**	2	288	15	7.5	48.0	2160			**2,160**
SCOUR POOL	5.2	**2**	0	37			18.5	230			**230**
	5.3	**9**	4	170	30	7.5	18.9	1275			**1,275**
	5.4	**5**	3	107	20	6.7	21.4	713	**315**	**2100.0**	**2,813**
	5.5	**1**	0	23			23.0	143			**143**
	5.6	**5**	2	67	9	4.5	13.4	302			**302**
DRY	9.0	**1**	0	1003							

Appendix 5

Incremental Cost Analysis

Upper York Creek
Incremental Cost Analysis

Without a monetary measure of project benefits, it is not possible to conduct a traditional benefit-cost analysis for the evaluation of project alternatives, thus a unique or "optimal" plan cannot be identified. However, an incremental cost analysis (ICA), a valuable planning tool, allowed us to examine the environmental outputs, rule out economically irrational alternatives and compare the relative cost effectiveness of the remaining plans. This is particularly useful in identifying and justifying the selection of a National Ecosystem Restoration (NER) Plan.

Key Assumptions

- Project outputs were expressed as the ***total number of fish*** that the restored habitat of Upper York Creek could support.
- Alternative 3, the "fish ladder", will yield a smaller number of outputs than the other three alternatives. The uncertainty of the outputs for this alternative will be expressed in a range of 1205-1710 fish values.
- Alternatives 1, 2a, and 2b will yield 1810 fish outputs.
- Project costs include the first costs, operations and maintenance, and interest during construction.
- Study life of 50 years, a construction period of two and a half years, and a FY '06 Federal Discount Rate of 5 1/8 percent.

Step 1 – Eliminating non-cost effective plans

For Upper York Creek, the alternatives were first ordered according to the highest level of output produced. Alternatives that produced identical outputs were identified; among these alternatives, the least cost alternative was retained, eliminating the non-cost effective plans. Alternatives 1, 2a, and 2b all produced the same number of outputs. Iteration one eliminated alternatives 1 and 2a because they produced the same number of outputs as alternative 2b, but with higher had higher costs. As stated earlier, alternative three produced a range of four separate outputs. Each output was treated independent of the other and for the selection purposes were treated as four separate alternatives during the selection of the most cost effective plan. The four alternatives were 3a, 3b, 3c, and 3d. Alternatives 3a, 3b, 3c, and 3d produced less outputs and had larger incremental and average costs than alternative 2b. Iterations 2-5 eliminated each of these alternatives.

Step 2 – Identifying the Least Incremental Cost Alternatives

Once the "non-cost effective" plans are eliminated, the ICA proceeds by treating the No Action plan as the first increment or baseline. Planners then select the best buy, i.e., the plan with the lowest incremental cost per unit. In this case, alternative 2b, is the next best alternative a planner can choose above the No Action plan. With a cost $240.44 per fish output this is the most efficient plan above the No Action plan. This plan is then stored and forms the baseline for the next iteration.

However, in this case, an additional iteration is not necessary since there is only one plan remaining. The identification of the least cost alternative is illustrated in the tables below.

Iteration 1

Plan	Total cost	Annual Cost	Incremental Cost	Output	Output	Cost Per Unit
		$	**$**	**(AAHU)**	**(AAHU)**	**($/AAHU)**
No Action	$ -	$0	$0	0	0	0
1	8,683,578.37	$484,891	$484,891	1810	1810	$267.90
2a	7,821,966.87	$436,779	$436,779	1810	1810	$241.31
2b	7,793,782.15	$435,205	$435,205	1810	1810	$240.44
3d	7,801,073.23	$435,612	$435,612	1205	1205	$361.50
3c	7,801,073.23	$435,612	$435,612	1330	1330	$327.53
3b	7,801,073.23	$435,612	$435,612	1465	1465	$297.35
3a	7,801,073.23	$435,612	$435,612	1710	1710	$254.74

Alternatives 1 and 2a are eliminated because they provide the same number of outputs as alternative 2b, but have higher costs

Iteration 2

Plan	Total cost	Annual Cost	Incremental Cost	Output	Output	Cost Per Unit
		$	**$**	**(AAHU)**	**(AAHU)**	**($/AAHU)**
No Action	$ -	$0	$0	0	0	0
2b	$7,793,782.15	$435,205	$435,205	1810	1810	$240.44
3d	$7,801,073.23	$435,612	$435,612	1205	1205	$361.50
3c	$7,801,073.23	$435,612	$435,612	1330	1330	$327.53
3b	$7,801,073.23	$435,612	$435,612	1465	1465	$297.35
3a	$7,801,073.23	$435,612	$435,612	1710	1710	$254.74

Alternative 3a is eliminated because it has a higher cost per unit than alternative 2b

Iteration 3

Plan	Total cost	Annual Cost	Incremental Cost	Output	Output	Cost Per Unit
		$	**$**	**(AAHU)**	**(AAHU)**	**($/AAHU)**
No Action	$ -	$0	$0	0	0	0
2b	$7,793,782.15	$435,205	$435,205	1810	1810	$240.44

3c	$7,801,073.23	$435,612	$435,612	1330	1330	$327.53
3b	$7,801,073.23	$435,612	$435,612	1465	1465	$297.35
3a	$7,801,073.23	$435,612	$435,612	1710	1710	$254.74

Alternative 3b is eliminated because it has a higher cost per unit than alternative 2b

Iteration 4

Plan	Total cost	Annual Cost	Incremental Cost	Output	Output	Cost Per Unit
		$	**$**	**(AAHU)**	**(AAHU)**	**($/AAHU)**
No Action	$ -	$0	$0	0	0	0
2b	$7,793,782.15	$435,205	$435,205	1810	1810	$240.44
3b	$7,801,073.23	$435,612	$435,612	1465	1465	$297.35
3a	$7,801,073.23	$435,612	$435,612	1710	1710	$254.74

Alternative 3c is eliminated because it has a higher cost per unit than alternative 2b

Iteration 5

Plan	Total cost	Annual Cost	Incremental Cost	Output	Output	Cost Per Unit
		$	**$**	**(AAHU)**	**(AAHU)**	**($/AAHU)**
No Action	$ -	$0	$0	0	0	0
2b	$7,793,782.15	$435,205	$435,205	1810	1810	$240.44
3a	$7,801,073.23	$435,612	$435,612	1710	1710	$254.74

Alternative 3d is eliminated because it has a higher cost per unit than alternative 2b

Plan	Total cost	Annual Cost	Incremental Cost	Output	Output	Cost Per Unit
		$	**$**	**(AAHU)**	**(AAHU)**	**($/AAHU)**
No Action	$ -	$0	$0	0	0	0
2b	$ 7,793,782.15	$435,205	$435,205	1810	1810	$240.44

Appendix 6

Sensitivity Analysis for the Use of Carrying Capacity for Project Benefits

Upper York Creek
Sensitivity Analysis for the Use of Carrying Capacity for Project Benefits

Fish outputs are based on estimates from NCRCD. NCRCD estimated the restored habitat could support a minimum of 825 and a maximum of 1810 fish. In addition to the high and low estimate provided through sampling, a value of 1310 was calculated to be used as a moderate estimate. The values for the high, moderate, and low estimate will be the output values for alternatives 1, 2a, and 2b.

For comparison purposes, it is estimated that a naturally engineered stream through the project site (Alternatives 1, 2A, and 2B) would provide 100% effectiveness for migrating steelhead. Alternative 3 has been determined to be less effective than the other three alternatives, as fish ladder blockages are expected to lower the effectiveness of the fish ladder for fish passage.

Although exact estimates are unknown, it is expected that during each storm, the fish ladder would become impassible until the ladder is cleared. In order to account for uncertainty and inefficiency, a high, moderate, and low estimate for alternative 3 outputs will be given in three separate ranges, 1205-1710, 880-1250, and 540-770 respectively. Each range will be provide four values of outputs, for example, the high estimate range will yield a values of 1205, 1330, 1465, and 1710.

Table 1 shows the high, moderate, and low output projections for each alternative. Table 2 displays the cost per fish output associated with the high, moderate, and low estimate for each alternative.

Table 1: Project Benefit Estimates Based on Carrying Capacity Estimates

Alternative	Percentage Effectiveness	Carrying Capacity *High Estimate*	Carrying Capacity *Moderate Estimate*	Carrying Capacity *Low Estimate*
Alternative 1	100%	1810	1310	825
Alternative 2A	100%	1810	1310	825
Alternative 2B	100%	1810	1310	825
Alternative 3a	67%	1205	880	540
	73%	1330	970	600
	81%	1465	1060	650
	95%	1710	1250	770

Table 2: Cost per Output for Each Alternative

Alternative	High Estimate Cost Per Output	Moderate Estimate Cost Per Output	Low Estimate Cost Per Output
Alternative 1	$267.90	$383.06	$591.33
Alternative 2a	$241.31	$346.61	$532.66
Alternative 2b	$240.44	$345.42	$530.74
Alternative 3a	$361.50	$539.02	$806.69
Alternative 3b	$327.53	$489.01	$726.02
Alternative 3c	$297.35	$447.49	$670.17
Alternative 3d	$254.74	$379.47	$565.73